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Report of the Study Group on Human Dimensions

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Executive Summary

In October 2009, the Study Group on *Human Dimensions* was established under the guidance of the PICES Science Board. The objective of the Study Group was to review the role of social science practices applied in decision-making in marine sectors around the world. In order to fully utilize the limited life span of the Study Group, the main focus was on ecosystem-based fisheries management (EBFM), with the following terms of reference:

1. Review how social science has been used/applied globally and regionally in EBFM and the theoretical basis for these practices;
2. Review the social scientific tools and information available for EBFM in PICES member countries;
3. Develop an inventory of practices for use of social economic information appropriate to the circumstances in each of PICES member countries (the term "best practice" is not used because it is expected what is "best" will vary and be determined according to the circumstances in each of PICES member countries);
4. Prepare a final report on activities and findings of the group and make recommendations on the desirability of establishing an expert group related to socio-economic sciences within PICES and on the role of such a group. For example, based on sound social and economic science, the potential expert group should first survey/assess the needs of potential stakeholders for FUTURE products, and scientifically clarify differences in societal objectives among stakeholders in different sectors and countries.

The Study Group found that there is a wide range of social scientific tools that can add value to natural scientific knowledge for better communication with society. For example, the social sciences can contribute to defining/selecting goals, objectives, indicators, and targets. Many quantitative analytical tools have been developed to assess the performance of specific measures which will facilitate inter-disciplinary collaboration among the natural and social sciences. When implementing EBFM measures, spatial, temporal, and organizational scales matter. The social sciences have also developed analytical tools for better coordination between existing institutional scales (stakeholders) and natural scientific knowledge. It was noted that PICES member countries are a rich source of information and data, and are already demonstrating examples of social science tool applications for EBFM.

In order to better understand and communicate the societal implications of the conditions and future trends of North Pacific marine ecosystems (a vision of the PICES FUTURE (**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems) program), to provide a forum for the integration of FUTURE-related studies using social science approaches and tools, and to facilitate the close discussions and communication among researchers from both the natural and social sciences, the Study Group recommends forming a new expert group on human dimensions. This expert group will conduct a survey to clarify differences in societal objectives and needs among stakeholders in different sectors and member countries and, on this basis, develop an inventory of potential recipients and their communication requirements for FUTURE and other PICES products. By closely coordinating and communicating with other expert groups in PICES, it will focus on the responses of human social systems to climate-induced changes in marine ecosystems, and will help tune the results from the natural sciences to be relevant (and to resonate with) the needs of societies in each PICES member country. Vulnerability analyses, selection of indicators on the human dimensions of EBFM, bioeconomics, and Sato-Umi (village seas) are all potential methods which can be applied to these issues. Based on these results, the expert group will be in a position to contribute to a Human Dimensions Chapter in the next Ecosystem Status Report, as well as to organize a symposium on the human dimensions of ecosystem-based fisheries management.

1 Introduction

The Implementation Plan for the new PICES integrative science program on **F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems (FUTURE) calls for PICES scientists to make the societal implications of their science more explicit and accessible through long-term engagement and communication among scientists, decision makers, stakeholders, and across sectors (PICES, 2009). Because different marine sectors view ecosystems in terms of their own economic, cultural and societal needs, the objective of ecosystem conservation is a "societal choice" (Principle 1 of the Ecosystem Approach of the Convention on Biological Diversity). Therefore, the social significance of predicted impacts from climate or ecosystem changes, and the types of information, advice and guidance to be requested of FUTURE might differ from country to country and sector to sector. Based on this understanding, the PICES Science Board recommended the formation of the Study Group on *Human Dimensions* (SG-HD), which was established in October 2009. The Study Group objective was to review the role of social science practices applied in decision-making in marine sectors around the world. In order to fully utilize the limited time frame of a Study Group, the main focus was on ecosystem-based fisheries management (EBFM), with the following terms of reference:

1. Review how social science has been used/applied regionally in EBFM and the theoretical basis for these practices;
2. Review the social scientific tools and information available for EBFM in PICES member countries;
3. Develop an inventory of practices for use of social economic information appropriate to the circumstances in each of the PICES member countries (the term "best practice" is not used because it is expected what is "best" will vary and be determined according to the circumstances in each PICES member country);
4. Prepare a final report on activities and findings of the group and make recommendations on the desirability of establishing an expert group related to socio-economic sciences within PICES and on the role of such group. For example, based on sound social and economic science, the potential expert group should first survey/assess the needs of potential stakeholders for FUTURE products, and scientifically clarify differences in societal objectives among stakeholders in different sectors and countries.

This is the final SG-HD report.

2 Rationale for Human Dimensions and Social Sciences

2.1 Background and Purpose of the Study Group on *Human Dimensions* (SG-HD)

Since the industrial revolution, man's impact on the oceans has increased dramatically, this being especially true in recent years. In nearshore coastal areas, human population growth has led to increasing pollution and habitat modification. In order to tackle this issue, the concept of Ecosystem Based Management (EBM) or Ecosystem Approach (EA) is now widely accepted as the standard strategy for achieving sustainable delivery of marine and estuarine ecosystem services (Francis *et al*., 2011). Under the overarching objective of conservation of species and habitat, EBM or EA is the implementation of defined objectives related to maintaining and monitoring biodiversity, productivity, and physical and chemical properties of an ecosystem (Jamieson and Zhang, 2005).

Under the PICES framework, there were two scientific activities associated with this theme. The first one was the Study Group on *Ecosystem-based Management Science and its Application to the North Pacific* (SG-EBM, 2003–2004, Co-chairs: Glen Jamieson and Chang-Ik Zhang). The other was the Working Group on *Ecosystem-based Management Science and its Application to the North Pacific* (WG 19, 2004–2009, Co-chairs: Glen Jamieson, Chang-Ik Zhang, and Patricia Livingston).

The SG-EBM reviewed and described existing and anticipated ecosystem-based management initiatives in PICES member countries, and found that the EBM challenges are different between China, Japan and Korea compared with Russia, Canada and the United States. On the western side of the Pacific, *i.e.*, China, Japan, and Korea, the much larger coastal populations are coupled with their much longer history of full exploitation of most harvestable renewable resources. This means that EBM is, at the least, focused on: (1) minimizing existing impacts, (2) rebuilding depleted stocks to acceptable levels, and (3) in nearshore areas in particular, minimizing widespread impacts in the marine environment from land runoff from both industrial and urban development. In contrast, in the three countries of the North and East Pacific, *i.e.*, Russia, Canada and United States, human coastal populations and coastal development are generally much less, with fishing impacts, offshore oil and gas development, and transport identified as the major impacts. In many instances, relatively unimpacted pristine habitats and biological communities still exist, and so the challenges in these regions often concern how to maintain them while permitting appropriate new economic activities to occur (Jamieson and Zhang, 2005).

Based on these findings, the subsequent Working Group (WG 19) developed a country matrix to summarize the progress made towards EBM in PICES member countries, and found that they used very diverse approaches. WG 19 also found that spatial issues were important for identifying stakeholders, defining objectives, conducting research, and implementing policies. In relation to this, the WG 19 final report concluded that collaboration with the social sciences is needed to develop effective indicators for marine "social-ecological systems" (Jamieson *et al*., 2010).

The concept of "social-ecological" systems is a relatively new idea. It recognizes that ecological (bio-physical or "natural") systems and human social systems (including cultural, management, economic, socio-political, and ethical aspects) are sub-systems of larger systems (Berkes and Folke, 1998; Ostrom 2009; Perry *et al*., 2010; Ommer *et al*., 2011). This means considering people as more than just "stressors" on marine ecosystems through fishing, habitat alterations, contaminants, *etc*. Instead, the concept of coupled and integrated social and ecological systems needs to be recognized.

Behind the concept of social-ecological systems, there exists an emerging recognition that good scientific (bio-physical or ecological) arguments for management actions are sometimes not accepted or implemented because of the perceived socio-economic or cultural costs. An integrated understanding of how ecosystem changes affect human social systems, and *vice versa*, is necessary to improve stewardship of marine ecosystems. Similar recognitions have been raised from ecosystem modeling studies. For example, Smith *et al*. (2009) noted that EBM policies and strategies that focus only on ecological outcomes are doomed to failure. They concluded that the social sciences could contribute at three levels in their simulation model, *i.e.*, behavior of individuals, behavior of communities and groups, and institutional dynamics and governance.

Based on these concepts, the Study Group on *Human Dimensions* (SG-HD) was established in 2009. The purpose of SG-HD was not to design management systems or plans, and outreach steps, but to review the role of social science practices applied in decision-making in marine sectors. In order to fully utilize the limited time frame of a Study Group, the main focus was on ecosystem-based fisheries management (EBFM, Pikitch *et al*., 2004) or Ecosystem Approach to Fisheries (EAF, Garcia and Cochrane, 2005), in particular in the North Pacific. Also, in order to achieve integrated discussions on social-ecological systems, the membership included both natural scientists and social scientists, as shown in Appendix 8.1. As indicated in the terms of reference in section 1, SG-HD reviewed social scientific tools as well as their applications in PICES member countries. The procedure of the Study Group's review work is provided in Appendix 8.2. Appendix 8.3 provides a summary of a topic session dealing with the interactions between natural and socio-economic issues in the context of ecosystem-based management, and the SG-HD report, from past PICES Annual Meetings.

2.2 Definition of Terms

In this section, the definitions of terms along with the concept of "social-ecological systems" in this report are provided. Some of them are very customary and common for everyone, but others may be different or new, especially for natural scientists. Also, the key words or key concepts in each term are provided to highlight the differences in the viewpoints among terms.

Fisheries Management (FM)

The United Nation's Food and Agriculture Organization's (FAO) Code of Conduct for Responsible Fisheries defines Fisheries Management to be the integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of fishery regulations by which the FM authority controls the present and future behaviors of the interested parties in the fishery, in order to ensure the continued productivity of the living resources (FAO, 1995). The key concepts or viewpoints in this term are fisheries sector, resource (species), and productivity in terms of volume and value.

Ecosystem Management (EM)

Ecologists define Ecosystem Management as management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function (Christensen *et al*., 1996). It is based on a management philosophy which focuses on desired states rather than system outputs and which recognizes the need to protect or restore critical ecological components, functions, and structures in order to sustain resources in perpetuity (Cortner *et al*., 1996). So, the key concepts or viewpoints in this term are native system *in situ*, habitat, and evolutionary and ecological processes.

Ecosystem Approach (EA)

Ecosystem Approach is a strategy for the integrated management of land, water, and living resources that promotes conservation and sustainable use in an equitable way (CBD, 2000). It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompass the essential processes, functions, and interactions among organisms and their environment. It recognizes that people, with their cultural diversity, are an integral component of ecosystems. As the operational guidance and 12 principles of EA show (http://www.cbd.int/ecosystem/implementation.shtml), the key concepts here are, in addition to that of EM, benefit-sharing, adaptive strategy, time and scale consistency, decentralization, and intersectoral cooperation.

Ecosystem-based Fisheries Management (EBFM) and Ecosystem Approach to Fisheries (EAF)

EBFM is an approach that takes major ecosystem components – both structural and functional – into account in managing fisheries (NRC, 1999). It essentially reverses the order of management priorities to start with the ecosystem rather than the target species (Pikitch *et al*., 2004). On the other hand, a similar term, EAF, was adopted by FAO to reflect the merger of two different but related paradigms, *i.e.*, ecosystem management and fisheries management. There are a lot of terms and acronyms related to EBFM or EAF (Garcia *et al*., 2003; Link 2010). In this report, SG-HD uses EBFM and EAF interchangeably and treats them as synonyms. Also, the Study Group considers EBFM (or EAF) to be an extension of conventional fisheries management, so that what is managed are not ecosystems but human activities.

To clarify the concept of EBFM, Fluharty *et al*. (2010) compared the relationships between FM, EBFM, and EM. FM is based on a traditional single-factor management approach. It considers only the factor or species being used, and physical habitats are occasionally considered if they are surrogate for population parameters. On the other hand, EM is an integrated management in an ecosystem context, which considers impacts of all the activities including fisheries on the status of the species being used and across the ecosystem. EM accommodates spatial needs and habitat impacts of such activities, and considers direct and indirect effects to ecosystems, as well as the status of communities and resilience of the community or system (Berkes and Folke, 1998). Fluharty *et al*. (2010) positioned EBFM between FM and EM. In addition to FM, in which the species or factors being used are considered, EBFM considers prey, dependent predators, food supply and impacts on ecosystems. In terms of physical habitats, EBFM considers productive capacity and the impacts of fisheries activities on habitats. Also, EBFM pays clear attention to environmental conditions such as productivity regimes and forcing, as well as biodiversity impacts on species which are not being used directly by the fisheries sector. The fundamental difference between EBFM and EBM is that the former considers various impacts from fisheries sectors only, while the latter includes all the other activities and sectors relating to marine ecosystem services. As for the definition of "ecosystem", we follow Jamieson *et al.* (2010), in which an ecosystem is defined as "the spatial unit and its organisms and natural processes (and cycles) that are being studied or managed."

Next, we need definitions of terms for the review of social scientific tools for EBFM.

Social science

Social science generally means a group of subjects concerned with the study of people within society. In this report, however, we focus on the relationships between human beings and ecosystems because the social-ecological system is one of the key concepts in our study. Therefore, we use the term "social science" to mean the group of subjects concerned with the relationships among people within society as well as among societies and the ecosystems in which people spend their lives.

The next section shows the results of the review work of SG-HD on social science tools for EBFM in various approaches or methodologies. So, the following terms need to be defined: a science tool, a scientific approach, and a scientific methodology.

A science tool is a tool, gear, or technique for doing scientific work, which can be applied in specified ways and purposes. A scientific approach is a way of dealing with scientific themes, a way of doing scientific work, or a logical process leading to a scientific result. Usually, a scientific approach uses a group of science tools. A scientific methodology is a combination of tools and approaches. A scientific discipline is a conventional category of training methodologies in educational institutions such as universities.

It is easy to understand these definitions if one imagines climbing a mountain. The tools one can use are alpenstock, mountain bikes, or cable cars (if these exist for the mountain being considered). The approaches one can choose are how to approach the summit (objective), *i.e.*, from the north, from the south, or via a smooth path, a steep rocky way, *etc*. Each approach needs its appropriate set of tools. Some tools can be used in various approaches, while others can be used only in a specific approach.

3 Social Sciences for Ecosystem-based Fisheries Management

3.1 Social Science Categories and Tools for EBFM

The SG-HD members conducted a thorough review of social science categories, and identified useful tools for EBFM. A preceding study on a similar theme, (De Young *et al*., 2008) summarized social science tools and methodologies into three categories: (1) decision-making tools, (2) information-acquisition and dissemination tools, and (3) process methodologies. In this report, social science tools were categorized into traditional academic disciplines. There are several reasons why SG-HD chose to categorize social science tools this way. First, the Group wanted to pay attention to the specific philosophies or viewpoints developed in each traditional discipline, because they will be intrinsically reflected in EBFM approaches. The same tools can be used in several disciplines and different approaches. Second, categorization based on discipline is easy to understand for most university-educated people, and can be referred to by professors and lecturers who are going to produce future scientists in the field of EBM or EBFM. Similarly, when a researcher is going to study new tools for EBFM, he/she can easily find the candidates for new tools in or near his/her discipline. Finally, a discipline-based list of tools can be effectively utilized when organizing problem-solving types of research programs within or across research institutes or universities.

The results of SG-HD's review work are summarized in Table 3.1. It shows the name of traditional academic disciplines, their general descriptions and typical tools. These tools can be applicable not only to EBFM but also to EBM, *i.e.*, analytical objects are not limited to the fisheries sector. As additional information, the table includes leading journals in English, from which readers can search appropriate research articles on how to use the tools for EBFM. In addition, several non-English journals published in PICES member countries are listed to find more applications in each area.

The disciplines and tools listed in Table 3.1 have the potential to improve EBFM by conducting analysis based on, for example, the following approaches.

Anthropology, especially cultural anthropology or ethnology studies, deals with, among others, cultural aspects of the human relationship with ecosystems. Its potential contribution to EBFM is large. For example, many native communities all over the world have practiced their own form of EBFM for traditional, small-scale, and community-based fisheries. Their management is largely based on their traditional view or ecosystem knowledge. Anthropology, especially cultural anthropology, can reveal their tacit knowledge of ecosystems or experiences of fisheries management which have accumulated over time. How people appreciate "healthy or desired ecosystems" or "threats", as well as their preferences in food consumption, are also deeply rooted in their culture.

Economics generally explores the production, distribution, allocation, and consumption of resources and services. Theoretical and empirical analyses can be used to address issues from the scale of individual households and businesses to the scale of industrial sectors, communities, regions, nations, and the world. It can contribute in various ways for better EBFM, and SG-HD divided it into six sub-categories:

- bioeconomic modeling,
- impact analysis,
- non-market valuation,
- decision theory,
- property right regimes,
- trade/development.

Bioeconomic models can be used to identify socially optimum levels of sustainable harvests, to determine optimal trajectories for rebuilding depleted populations of living marine resources and recovery of compromised habitats, and to determine optimal size and spacing of marine protected areas.

Table 3.1 Social science disciplines and tools.

Discipline	General description and typical tools	Leading journals in English	Leading non-English journals
Anthropology / Ethnology	Anthropology, especially cultural (social) anthropology or ethnology, covers resources relating to the scientific study of human beings, such as their distribution, behavior, social and cultural characteristics or development. This category, by definition, borrows from related resources in history, archaeology, ethnology, folklore and several other social sciences. Typical tools in this field are participatory observation and evaluation, interviews, excursion, surveys/questionnaires, field work, comparison, and data analysis.	• Human Nature - An Interdisciplinary Biosocial Perspective (Springer), • Human Ecology (Springer), • Annual Review of Anthropology (Annual Reviews)	• Seri Ethnological Studies (Japan), • Anthropological Journal (Japan), • Japanese Journal of Human Geography (Japan), • Ethno-National Studies (China), • Journal of Sociology and Social Anthropology (Russian)
Economics (bioeconomic modeling)	Bioeconomic modeling combines models of the behavior and dynamics of biological or ecological systems with economic models of the net value of production and consumption of goods and services produced by the biological or ecological systems. At its simplest, the bioeconomic model relies on the biological or ecological model to identify the suite of feasible states of the biological or ecological system and then uses an economic model of market and non-market benefits to identify the particular state of the biological or ecological system that will maximize value to society as a whole. The toolkit for bioeconomic modeling includes: optimal control theory, cost/benefit analysis, and simulations.	• Natural Resource Modeling (Wiley-Blackwell), • Marine Resource Economics (MRE Foundation), • North American Journal of Fisheries Management (American Fisheries Society), • Canadian Journal of Fisheries and Aquatic Sciences (NRC Press), • Journal of Environmental Economics and Management (Elsevier), • American Journal of Agricultural Economics (Wiley-Blackwell), • Environmental and Resource Economics (Springer)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Review of Environmental Economics and Policy Studies (Japan), • Chinese Fisheries Economics (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Izvestiya TINRO (Russian Journal of Marine Biology) (Russia), • Voprosy Rybolovstva (Fisheries Research) (Russia)
Economics (impact analysis)	Economic impact analysis characterizes the operation of regional-scale economies, tracing how changes in the economic activity of one sector induce changes in spending and employment in other sectors within and between regions and through time. Typical tools are input-output analysis, computable general equilibrium models, cost-benefit analysis, and economic dependency measures.	• Annals of Regional Science (Springer Verlag), • Journal of Regional Science (Wiley-Blackwell), • Marine Resource Economics (MRE Foundation), • Land Economics (University of Wisconsin), • Environmental and Resource Economics (Springer)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Journal of the North Japan Fisheries Economics (Japan), • Chinese Rural Economy (China), • Chinese Fisheries Economics (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Rybnoe Khozyaystvo (Fisheries) (Russia), • Morskoy Sbornik (Marine Bulletin) (Russia)

Table 3.1 Continued

Discipline	General description and typical tools	Leading journals in English	Leading non-English journals
Economics (non-market valuation)	Non-market valuation describes the theoretical characterization and empirical estimation of the value, positive or negative, of goods and services that are not transacted in economic markets. Examples of non-market goods and services include externalities (*e.g.*, pollution), public goods (*e.g.*, scenic vistas, ecosystem services, wildlife viewing), and recreation. Tools used in non-market valuation studies include contingent valuation, hedonic pricing, the Travel Cost Method, discrete choice models, and economic experiments.	• Journal of Environmental Economics and Management (Elsevier), • Environmental and Resource Economics (Springer), • American Journal of Agriculture Economics (Wiley-Blackwell), • Land Economics (University of Wisconsin), • Marine Resource Economics (MRE Foundation), • Ecological Economics (Elsevier), • Environmental Values (White Horse Press)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Economics Research Journal (China), • The Journal of World Economy (China), • Chinese Fisheries Economics (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Rybnoe Khozyaystvo (Fisheries) (Russia)
Economics (decision theory)	Decision theory consists of a variety of conceptual and applied methods for combining information from diverse sources and singular or multiple criteria to identify the best decision. Decision theory extends to decision-making under uncertainty and in the face of risk as well as decision making when faced with cooperative or non-cooperative opponent (*e.g.*, another firm, another nation, or nature). Tools applied in decision theoretics include: problem tree/decision tree analysis, game theory, multi-attribute utility analysis, Delphi methods, risk analysis, analytic hierarchy process, and decision trees.	• Annals of Operations Research (J.C. Baltzer AG, Science Publishers), • Operations Research (Informs), • Natural Resource Modeling (Wiley-Blackwell), • Marine Resource Economics (MRE Foundation), • North American Journal of Fisheries Management (American Fisheries Society), • Canadian Journal of Fisheries and Aquatic Sciences (NRC Press)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Operations Research of Japan (Japan), • Chinese Fisheries Economics (China), • Chinese Rural Economy (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Izvestiya TINRO (Russia)
Economics (property right regimes)	The rules that societies use to allocate access to and condition the use of living marine resources and their environments have a profound influence on the way the resources are used, the sustainability of those uses, and on the distribution of benefits and costs across society. Prevalent property right regimes include, *e.g.*, open access, common property, limited entry, individual fishing quotas (IFQs), territorial use rights in fishing (TURFs), community quotas, sector allocations, and fishing cooperatives. The study of property right regimes, particularly those that address the common-pool resource dilemma, is an academic focus of resource economists, anthropologists, sociologists, lawyers, human ecologists, and game theorists. The toolkit for evaluation of property right regimes is very diverse, running from ethnographies, interviews, and surveys to analyses of legal foundations and precedents to bioeconomic and decision theoretic models.	• Journal of Environmental Economics and Management (Elsevier), • Land Economics (University of Wisconsin), • Natural Resources Journal (University of New Mexico), • Human Ecology (Springer), • Marine Resource Economics (MRE Foundation), • Marine Policy (Elsevier), • North American Journal of Fisheries Management (American Fisheries Society), • Canadian Journal of Fisheries and Aquatic Sciences (NRC Press), • Environmental and Resource Economics (Springer), • Journal of Agricultural and Resource Economics (Western Agricultural Economics Association), • Journal of Regulatory Economics (Springer)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Journal of the North Japan Fisheries Economics (Japan), • Economics Research Journal (China), • Chinese Fisheries Economics (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Ocean and Polar Research (Korea), • Ocean Policy Research (Korea), • Theory and Practice of Marine Activities (Russia)

Table 3.1 Continued

Discipline	General description and typical tools	Leading journals in English	Leading non-English journals
Economics (trade / development)	International trade policies (tariffs and non-tariff barriers, exchange rate manipulation, *etc.*) and international economic development activities affect the cost of input factors and the value of products, especially when the products and their input factors are integrated into international trade markets. Many countries subsidize fisheries production and impose trade-distorting tariffs on fish imports or exports. Together, these macroeconomic policies influence the intensity of fishing pressure and habitat modification. Similarly, development policies of donor nations, the UN, and the World Bank affect fisheries, through, *e.g.*, loans and grants that increase fleet capacity, encourage modernization/ industrialization of fishing vessels, and encourage development of coastal zone aquaculture. The toolkit includes case studies of the macro, micro, and regional economic consequences of trade policies and economic development programs, theoretical and empirical models of international trade, trade liberalization, and regional economic cooperation/integration	• Journal of Environmental Economics and Management (Elsevier), • Journal of Public Economics (Elsevier), • Journal of Political Economy (University of Chicago), • Journal of Development Studies (Taylor & Francis), • Environment and Trade (UNEP), • Review of Development Economics (Wiley-Blackwell), • Journal of Environment and Development (Sage Publications)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Journal of the North Japan Fisheries Economics (Japan), • Journal of International Trade (China), • The Journal of World Economy (China), • International Economic Review (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Ocean Policy Research (Korea), • Theory and Practice of Marine Activities (Russia), • Rybnoe Khozyaystvo (Fisheries) (Russia), • Global Economy and International Relations (Russia)
Environmental accounting	Environmental accounting is the application of national accounts concepts and classification for producing statistical descriptions of the inter-relationships between the economy and environment.	• Ecological Economics (Elsevier), • Environmental Values (White Horse Press)	• Review of Environmental Economics and Policy Studies (Japan), • Accounting Research (China), • Chinese Fisheries Economics (China), • Economics and Business (Russia), • Voprosy Economiki (Economics Research) (Russia)
Geography / area studies	Geography covers resources concerned with socio-cultural aspects of the Earth's surface emphasizing the human, economic, political, urban, cultural, biological, and environmental issues of the discipline. Geospatial information technologies, which include Global Positioning System (GPS), Remote Sensing (RS), Geographic Information System (GIS), *etc.*, are highly developed for data collection and analysis. Main tools applicable to EBFM are community profiling, asset mapping, and marine use analysis by GIS.	• Journal of Regional Science (Wiley-Blackwell), • Progress in Human Geography (Sage Publications), • Economic Geography (Clark University), • Political Geography (Elsevier), • Environment and Planning (Pion), • Environmental Impact Assessment Review (Elsevier), • Cultural Geographies (Sage Publications), • Regional Studies (Routledge), • International Regional Science Review (Sage Publications)	• Journal of Regional Fisheries (Japan), • Human Geography (Japan), • Geographical Review of Japan (Japan), • Acta Geographica Sinica (China), • Pacific Oceanography (Russia)

Table 3.1 Continued

Discipline	General description and typical tools	Leading journals in English	Leading non-English journals
Law	This discipline seeks a deeper understanding of the nature of law, legal reasoning, legal systems and legal institutions. Major tools are comparative law, legal history, legal philosophy, legal sociology, case law studies, and law and economics (economic analysis of law).	• Ecology Law Quarterly (University of California Berkeley), • Harvard Environmental Law Review (Harvard Law School), • Journal of Law and Economics (University of Chicago Press), • Natural Resources Journal (University of New Mexico), • Columbia Law Review, Harvard Law Review, Yale Law Review, University of California Los Angeles Law Review, Stanford Law Review	• Ocean Bulletin (Kaiyo Jiho) (Japan), • Journal of Law (China), • Chinese Fisheries Economics (China), • Ocean Policy Research (Korea), • Marine Law and Practice (Russia)
Policy science	Policy analysis deals mainly with policy background, decision-making, implementation, costs, effects, *etc*. In all but the most rudimentary applications, the normative dimension is inescapable in policy science. Major tools include institutional analysis, discourse analysis/content analysis, public choice, process analysis, decision-analysis, bureaucracy and administration, performance evaluation, trade-off analysis/impact assessment, benefit-cost analysis, *ex-post*/*ex-ante* assessments, stakeholder analysis, and survey research.	• Marine Policy (Elsevier), • Food Policy (Elsevier), • Global Environmental Change-Human and Policy Dimensions (Elsevier), • Journal of Political Economy (University of Chicago Press), • Journal of Policy Analysis and Management (John Wiley and Sons), • Political Analysis (OUP), • Governance (Wiley-Blackwell), • Environmental Politics (Routledge), • Resource Policy (Elsevier)	• Journal of Marine Policy (Japan), • Management World (China), • Ocean Policy Research (Korea), • Journal of Social Policy Studies (Russian), • Global Economy and International Relations (Russia)
Psychology (social or applied)	Psychology (applied/social) covers resources on individual/organizational/social psychology, including cognition, selection, organizational behavior and development.	• Journal of Environmental Psychology (Elsevier), • Organizational Behavior and Human Decision Processes (Elsevier)	• Japanese Association of Industrial/Organizational Psychology Journal (Japan), • Japanese Journal of Social Psychology (Japan), • Philosophical Researches (China), • Acta Psychologica Sinica (China), • Psychology (Russia), • Vestnik of Moscow State University, Ser. 14. Psychology (Russia)

Table 3.1 Continued

Discipline	General description and typical tools	Leading journals in English	Leading non-English journals
Seafood business	"Seafood business" is composed of business administration, seafood distribution systems, fish processing, food management, retail marketing, and consumer dynamics. This field has been the focus of business activity, as it is based on profitability; therefore, this field has not been discussed in the context of marine science. Also, this fields deals with safety and stability of food provision to consumers. Main tools are marketing/ promotion/ exposition, logistics, organizational analysis, demand-supply analysis, price theory, working process analysis, chemical testing and evaluation, consumer research (focus group, conjoint analysis, analytic hierarchy process, *etc.*), and distribution system analysis.	• Seafood Business (Diversified Business Communications), • Seafood International (InterFish), • Seafood Processor (Highway - a division of Informa and Transport), • Western Fisheries (Fisheries Department of Western Australia), • Southern Fisheries (a joint publication of the Department of Primary Industry-Fisheries and the South Australian Research and Development Institute)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Food System Research (Japan), • Journal of Market History (Japan), • Chinese Fisheries Economics (China), • Food Industry (Russia), • Fish and Seafood (Russia)
Sociology	Sociology covers disciplines that focus on the study of human society, social structures, and social change as well as human behavior as it is shaped by social forces. Main tools for EBFM are interviews, stakeholder analysis, surveys/questionnaires (interviews, observation, paper + telephone), and field work.	• Rural Sociology (Rural Sociological Society), • Society and Natural Resources (Taylor and Francis), • Agriculture and Human Values (Springer), • Human Studies (Springer), • American Sociological Review (American Sociological Association), • Environment and Behavior (Sage Publications), • Organization and Environment (Sage Publications)	• Journal of Environmental Sociology (Japan), • Journal of Regional Fisheries (Japan), • Sociological Studies (China), • Sociology: Methodology, Methods, Mathematical Models (Russia)
Aquaculture	Confined aquaculture and ocean ranching interact with sport and commercial fisheries in terms of ecology, economics, business, and law. Models of optimal structure for aquaculture operations, models of market competition between aquaculture and wild fisheries.	• American Journal of Agricultural Economics (Wiley-Blackwell), • Marine Resource Economics (MRE Foundation), • Aquaculture Economics and Management (Taylor and Francis)	• Japanese Journal of Fisheries Economics (Japan), • Journal of Regional Fisheries (Japan), • Journal of the North Japan Fisheries Economics (Japan), • Journal of Fishery Sciences of China (China), • Chinese Fisheries Economics (China), • Environmental and Resource Economics Review (Korea), • The Journal of Fisheries Business Administration (Korea), • Ocean Policy Research (Korea), • Theory and Practice of Marine Activities (Russia), • Rybnoe Khozyaystvo (Fisheries) (Russia), • Izvestiya TINRO (Russian Journal of Marine Biology) (Russia)
Other inter-disciplinary fields	There are many inter-disciplinary fields relating to EBFM. For example, risk analysis for disasters, food safety, environmental degradations, goal ranking analysis, and communication strategy planning. Education and empowerment tools for stakeholders (transect diagram and walk, participatory learning, visioning, *etc.*) are the most important for training next generations.	• Risk Analysis, Ecology and Society, Fish and Fisheries (Wiley-Blackwell), • Annual Review of Environment and Resources (Annual Reviews), • Journal of Environmental Education (Heldref Publications)	• Nippon Suisan Gakkai Shi (Japan), • Economic Perspectives (China), • Exploration and Preservation of Natural Resources in Russia (Russia).

Theoretical models can be used to derive characteristics of optimal solutions; empirical models can be used to develop policy recommendations or to analyze the consequences of policy choices. Bioeconomic models can be specified as dynamic or static, stochastic or deterministic, discrete or continuous time, single or multispecies. Empirical bioeconomic models often form the core of simulation models used to explore the probable consequences of policy options or to test the sensitivity of the optimal solution(s) to perturbations of parameter values.

Economic impact analyses are useful to measure the fine scale (economic sector, community, state, or country) consequences of management actions (*e.g.*, changes in regulations) or changes in external drivers (*e.g.*, changes in input or output prices, the availability of labor, catch limits, or revised allocations between fishing sectors). Key indicators from regional economic models include changes in employment, in personal income, and in expenditures for inputs. Regional economic models may also provide estimates of economic multipliers and measures of economic dependency. Economic multipliers characterize the extent to which expenditures within a regional economy stimulate additional economic activity. Economic dependency measures attempt to characterize the extent to which regional economies are dominated by, and thus thrive or collapse, depending on the performance of individual economic sectors such as fishing.

Economic markets are efficient (maximize value to society) at allocating goods and services when the benefits and costs of those goods and services fully accrue to market participants. When private production and consumption decisions do not reflect the full public benefits or costs of the decisions, market transactions will lead to overproduction or overconsumption of goods and services that generate negative externalities, and market transactions will lead to the undersupply of goods and services that yield valuable public benefits. Non-market valuation is a collection of methods designed to estimate the value of goods and services that are not well represented in market transactions. Because society benefits (or is harmed) by the production of both marketed and non-marketed goods and services, it is important that resource managers have access to estimates of both when weighing decisions about the exploitation or preservation of ecosystems.

It is worth pointing out here that there are important discussions going on among experts and researchers about the abilities and issues in ecosystem valuations. For example, natural ecosystems yield services that have intrinsic value for their ability to support fisheries and other extractive uses, for their contribution to water and atmospheric cycles, for their ability to absorb effluents, and for their amenity benefits. In contrast to extractive uses such as fisheries, which can be readily monetized, the value of many of these other ecosystem services are not easily monetized and are often ignored until ecosystems are substantially impaired through pollution, physical disruption, or eutrophication. Societies tend to underinvest in services that are not monetized. Ecosystem valuation has been explored through a variety of methodologies (see, *e.g.*, Bingham *et al*., 1995). Examples include assessment of the contribution of saltwater marshes, mangroves, estuaries, and coral reefs to the reproduction and juvenile survival of commercially harvested fish and shellfish. Another application of ecosystem valuation has been to estimate the avoided cost of advanced wastewater treatment if the nearshore environment were unable to processes sewage discharge – the implication being that society would begin to incur the costs of wastewater treatment if the marine environment became so impaired that it was unable to absorb the sewage discharge. Ecosystem value assessment also plays a critical role in determining the damages associated with pollution events, *e.g.*, cases in Russia (section 4.5) or natural disasters, *e.g.*, tsunamis, hurricanes, and earthquakes. In these cases, ecosystem valuation is often called "natural resource damage assessment" and the lost value of ecosystem services acts as a basis for awarding damages against responsible parties and compensating those who have lost the benefits of unimpaired ecosystem services (see *e.g.*, French *et al*., 1996 and Ward and Duffield, 1992).

The next economic sub-category is decision theory. Choices about the goals and objectives of EBFM and the means to achieve these goals and objectives are complex, uncertain, and controversial. Decision theoretic tools can be used to formalize the process of developing the goals and selecting the means, and to reveal inconsistencies between the selected means and intended outcomes. These techniques have been used to evaluate management strategies for transboundary fisheries, and to organize stakeholder input on the relative importance of competing objectives and preferences for alternative mechanisms for pursuing those objectives.

The outcome of resource management, whether for single species or for ecosystems, is largely predetermined by the established rules that govern access to, and use of, living marine resources and their habitat. Property right regime studies deal with such aspects of EBFM. They include a group of various social sciences, but in this report it is placed as a sub-category in economics. For example, solving the common-pool dilemma is the key to sustainability. That many societies have thrived for extended periods of time is clear testimony to their ability to devise institutions (rules to structure access to common resources) that were feasible, enforceable, and sustainable. The litany of collapses of marine populations and the ecosystems that support them is clear evidence that poorly designed or poorly enforced property rights regimes will trump any effort at "scientific" management. Anthropologists, sociologists, human ecologists, resource economists, game theorists, and lawyers have learned many lessons about the design features of successful solutions to the common-pool dilemma and pathologies of unsuccessful resource management regimes. These lessons reveal universal principals and unique case-specific findings that should prove invaluable in the design of EBFM systems.

Trade and development studies have developed their own concepts and approaches in economic theory, and are the final sub-category. Economic development programs and trade policies can work in concert with, or in opposition to, the goals and objectives of EBFM. The effect of these policies and programs should be considered in the choice of management strategies for EBFM. In addition, the implementation of development programs and the promulgation of trade policies should take in to account EBFM goals and objectives.

By integrating environmental and economic data into a coherent framework, environmental accounts significantly increase the capacity to evaluate economic activity and its dependence upon the natural environment as a source of materials and energy, and as a sink for waste products. The framework revolves around an integrated information system that also provides clear guidance for environmental data collection. In the context of fisheries resources, environmental accounting brings more systematic organization and coherence to scientific and socio-economic datasets through the adoption of standard classification, development of consistent time series, and enablement of international comparisons. It is an analytical tool for fisheries managers, policymakers, and researchers alike.

The contributions of geography, especially Geographical Information Systems (GIS), have already become an indispensable tool for promoting EBFM or EAF. Many case studies have been reported in the FAO Fisheries and Aquaculture technical paper on "Geographic Information Systems to support the ecosystem approach to fisheries" (Carocci *et al*., 2009). GIS is an important tool to integrate data and analytical results from wide-ranging disciplines into a visually understandable manner, which leads to better communication with stakeholders.

Any measures for implementing EBFM must follow international and domestic laws. In other words, international and domestic legal components are very much in the background of EBFM. In the 1970s and 1980s, almost no critical attention was paid by legal scholars to these issues with the exception of the Regional Fisheries Management Organization, and in the Arctic. Very little work was being done except when laws were reauthorized or revised, and even then analyses were mostly *post-hoc*. Virtually zero comparative domestic law work has been done. We have to consider legal challenges for the integration of marine policy and management as well as to adapt to climate change. The targets of Domestic Law of the Oceans are exclusive economic zones (EEZ), fisheries, marine pollution, coastal and marine spatial planning, marine transportation, offshore mineral and oil, and invasive species.

Also important for implementation is a field called policy science. Policy science for EBFM deals with the nature of public policy, its decision-making and implementation processes, administrative structure, and financial feasibility. Based on these analyses, the roles of government, industry, academics, NGOs, consumers, *etc.*, and their appropriate strategies for EBFM, can be discussed.

Psychology, especially social psychology, has been an indispensable social scientific area for understanding many problems concerned with fisheries. Social psychology has a close relationship to economics (behavioral economics) and often involves game theory to explain social phenomena, including fisheries. For example, Hardin's (1968) "tragedy of the commons" is often used to explain an overexploitation of the stock which is not managed based on "property rights". The "prisoner's dilemma" (Axelrod, 1984) is also cited for explaining an overinvestment in the fishery or seafood industry. A benefit of social psychology is that it can explain phenomena which cannot be described by general economic theory. Group dynamics or social influences are good examples, and the understanding of these phenomena is very important for not only explaining the activities of fishers but also for designing fisheries management plans or systems. Psychology has already played important roles in social impact assessments. Pollnac *et al*. (2006) suggested the application of this approach to fisheries, especially for assessing the satisfaction of stakeholders such as fisheries workers and local citizens.

Under EBFM, private companies have been increasingly required to conduct ecologically sustainable business operations with low environmental burdens. At the same time, companies must pursue, by definition, profits. The seafood business seeks practical business strategies under which ecosystems and fisheries can exist in productive harmony.

Sociology has many branches and its target spreads from the small community level to the global scale. EBFM is often merged with an idea of community-based fisheries management (CBFM) and is known as a community-based ecosystem approach to fisheries management (CEAFM). Sociology, especially community studies, has a very important role for analyzing the relationships between small communities and their surrounding ecosystems.

Aquaculture, which is fundamentally different from the wild capture fisheries, could be one discipline applicable and indispensable for EBFM studies. The spatial allocation of sustainable aquaculture sites is one important theme in marine planning or EBFM.

3.2 The Role of Social Sciences for Better EBFM

Using the approaches and tools summarized in the previous section, the social sciences can deal with various EBFM issues, which have traditionally not been analyzed or discussed in the field of natural sciences.

There are many studies or documents which discuss the procedures or processes for implementing EBFM (*e.g.*, Garcia *et al*., 2003; Jennings and Rice, 2011), but few of them have discussed how to define or select the goals, objectives, indicators, or targets. Principle 1 of the CBD Ecosystem Approach states the objective of ecosystem conservation is a "societal choice" (Smith and Maltby, 2003). We clearly need sound social scientific analyses when setting or selecting the objectives, goals, indicators, or targets for planning and implementing EBFM activities. For example, sound understanding of what people care about, or how they appreciate ecosystems, is the foundation of such processes (see, *e.g.*, the Japanese case study in section 4.2 and Puget Sound case study in section 4.6). Indicators are expected to reduce the complexity of ecological systems to a small set of synthetic indices of system state (Rice and Rochet, 2005). However, social, economic, or institutional indicators for human dimensions are less well-developed than for ecological indicators.

Many social sciences have developed not only qualitative approaches and tools for descriptions, but also quantitative analysis approaches and tools for numerical verification of the results. Such approaches and tools are compatible to natural scientific findings or simulation results for EBFM, and *vice versa*. In that sense, social sciences can contribute to judging or assessing the social and economic performances of EBFM measures. In particular, many analytical tools have been developed in economics and environmental accounting to quantitatively assess the "efficiency" of specific measures. In addition, tools in sociology, anthropology, and psychology can be used to conduct sound analysis on other social criteria such as "sufficiency", "fairness", and "appropriateness"., "Resilience" and "adaptive capacity" are also important criteria for assessing EBFM and societal responses.

When implementing EBFM measures, the scale issue is an important and non-trivial aspect. Social sciences can propose spatial, temporal, and organizational scales for EBFM, coordinate with existing institutional scales and stakeholders, and provide natural scientific knowledge. Because some socio-economic information is easier for stakeholders to understand than the natural scientific type and therefore, is more useful to explain, the social sciences can promote natural scientific understanding to stakeholders. Overall, by conducting these analyses, the social sciences can improve the value of the information produced by natural sciences for better understanding by the public, administrative officials and fishers.

4 Application of Social Sciences for EBFM in PICES Member Countries

In this section, three examples of the application of social sciences are introduced for each PICES member country. A summary of 18 case studies is shown in Table 4.1. Note that these are just typical examples from the growing number of experiences in the member countries, and not a comprehensive catalogue of applications. Many other application cases can be found in the journals listed in Table 3.1.

4.1 Canada

Environmental accounting framework in Canada

As the nation-wide initiative for developing EBFM, environmental accounting concepts are being applied to monitor and assess the economic importance, impacts, full costs, and benefits of fisheries management. It is composed of the asset accounts (economic value of stocks of human-made capital, *i.e.*, fishing fleets/vessels, fish processing capacity), flow accounts (employment in fisheries sectors, dependencies on fishing and related activities) and economic impacts of marine-related activities in Canada. The environmental accounting framework will also find enhanced applications in more recent efforts towards the development of an ecosystem goods and services framework (Statistics Canada, 2006). Several typical examples of empirical estimates are as follows:

1. Material and energy flow accounts: record, in physical terms, the flow of materials and energy – in the form of natural resources and wastes – between the economy and the environment. They are directly linked to the input–output accounts of the Canadian System of National Accounts (CSNA). This linkage enables the calculation of key indicators of the resource and waste intensity of economic activity.
2. Natural resource stock accounts: measure quantities of natural resource stocks (oil, natural gas, minerals, timber, and land) and the annual changes in these stocks due to natural processes and human activity. These accounts, which are recorded using both physical and monetary units, form the basis of the estimates of Canada's natural resource wealth that are included in the Canadian national balance sheet accounts.
3. Measuring renewable water assets in Canada: Empirical work on environmental accounting of fisheries and other aquatic resources is not yet fully implemented in Canada.

Pacific North Coast Integrated Management Area

The Pacific North Coast Integrated Management Area (PNCIMA) is the coastal area facing the U.S. border at Alaska in the north, the base of the continental shelf in the west, Brooks Peninsula in the southwest, and the point of separation of Johnstone Strait and Strait of Georgia in the southwest. Its ecosystem management goal is to ensure a healthy and prosperous ocean area by working with all interested parties to develop and implement a plan to manage human activities in a comprehensive manner that balances ecological, economic, social, and cultural interests. The governing body includes a wide range of representatives from federal (*e.g.*, Fisheries and Oceans Canada (DFO), Environment Canada, Natural Resources Canada, Transport Canada), and provincial (British Columbia and regional districts) governments, and First Nations organizations (Nanwakolas Council of First Nations, Council of the Haida Nation, Central Coast First Nations Committee, North Coast Skeena First Nations Stewardship Society, *etc*.). The PNCIMA Initiative is now preparing an integrated management plan. In order to develop the conservation objectives for the area, Marine Use Analyses are being conducted, which include tools from anthropology (how communities use this marine environment), economics (analyses of monetary and on-monetary economic values), and policy issues (legal analysis and policy science).

Table 4.1 Applications of social science approaches and tools in PICES member countries.

Location	Social science approaches or tools applied or being applied	Purpose
Canada		
Nationwide	Environmental accounting system	To monitor and assess the economic importance, impacts, full costs and benefits of fisheries management
Pacific North Coast	Marine Use Analysis based on anthropology, economics, and policy science	To develop of conservation objectives for the Pacific North Coast Integrated Management Area (PNCIMA)
British Columbia	Anthropology, economics, aquaculture, legal analysis (*e.g.*, issues of native rights and title)	To propose and evaluate the human aspects of potential locations for marine protected areas (MPAs)
Japan		
Nationwide	Delphi methods and social surveys (web-based questionnaires)	To identify the objectives, grasp the public policy demands, and prioritize the objectives for fisheries management and the integrated use of EEZ
Shiretoko Peninsula	Institutional analysis, policy cost-benefit analysis	To propose necessary policy measures, and to evaluate the efficiency of EBFM measures
Okinawa	Anthropologic and sociological tools; non-market valuation tool	To understand the relationship between the human society and coastal ecosystems (historical process, culture, society and economics, relation to human lives), and to evaluate ecosystem services being conferred
People's Republic of China		
Nationwide	Institutional analysis based on property right regimes and policy circle theory	To identify the gap between existing fisheries management framework and EBFM, and to propose necessary road map for better management
Nationwide	GIS analysis which integrates bio-physical factors and socio-economic and policy factors	To recommend suitable areas for sustainable aquaculture and better communicate with stakeholders.
Nationwide	Non-market valuation software	To evaluate the total marine ecosystem service values (applied to the Yellow Sea, South China Sea, East China Sea, Bohai Sea)

Table 4.1 Continued

Location	Social science approaches or tools applied or being applied	Purpose
Republic of Korea		
Nationwide	Social and economic risk analysis on economic revenue, seafood markets, and employment (IFRAME)	To propose new management measures for the large purse seine fishery
Nationwide	Economic tools (net present value, cost-benefit ratio, internal rate of return, non-market valuation)	To estimate increases in ecosystem service (cultural service) by the release of Oliver flounder fry
East coast	Bioeconomic model	To propose feasible policy options for stock recovery of ecologically and economically important species (sand fish)
Russia		
Kamchatka Region and Prymorsky Kray	Non-market valuation	To evaluate the total marine ecosystem service values
Sakhalin Island	Estimation of economic losses	To asses economic losses from marine pollution and water engineering
Prymorsky Kray	Estimation of economic losses	To asses economic losses from marine pollution and water engineering
United States of America		
Nationwide	Economic, sociology, geography, and seafood business	To secure environmental justice and incorporate social and economic factors into decision making
Alaska	Opportunity costs, enforcement costs, impacts on small entities, fleet composition, and distribution trends in the human population	To assess management efficiency, and social and economic impacts of fisheries management
Puget Sound	Cognitive analysis, stakeholder participation, and risk analysis	To set a definition of a healthy ecosystem, to identify threats, and to prioritize various indicators

IFRAME - Integrated Fisheries Risk Assessment, Forecasting and Management for Ecosystems

Marine protected areas in British Columbia

The first marine waters in British Columbia were protected in 1911 as part of Strathcona Provincial Park. Since that time, over 100 other marine protected areas (MPAs) have been designated. Recently, a Marine Protected Areas Implementation Team (MPAIT) has been formed, with participation by both federal (DFO, Parks Canada) and provincial (Lands and Forests, Environment) governments. There are two panels that provide biological/physical and socio-economic advice for MPA design. The socio-economic team is proposing to use tools in anthropology, economics, aquaculture siting and their ecological and economic interactions, legal issues (*e.g.*, issues of native rights and title) to evaluate the human aspects of locations being considered as protected areas. Also, based on GIS analysis, cumulative human impacts (including fisheries) and their spatial characteristics in the ecosystem, are being analyzed (Ban *et al*., 2010).

4.2 Japan

Social survey on public demands for ocean policy

In 2007, the Basic Act on Ocean Policy was enacted to clarify the principles of ocean policy in Japan, covering all the marine-related industries, including fisheries. The six basic principles set down in this Act are:

1. harmonization of the development and use of the oceans in ways that conserve the marine environment,
2. ensuring safety and security on the oceans,
3. improvement of scientific knowledge of the oceans,
4. sound development of ocean industries,
5. comprehensive governance of the oceans, and
6. international partnership with regard to the oceans (Makino, 2011).

Based on this Act, the Headquarters for Ocean Policy, headed by the Prime Minister of Japan, was established in the Cabinet, and the Basic Plan on Ocean Policy was formulated in 2008. This Basic Plan prescribes in more detail the direction of ocean policy in Japan. In accordance with it, the Fisheries Research Agency (FRA) identified five objectives of Japanese fisheries management (resource and ecosystem conservation; seafood provision; industrial and economic development; local and community development; cultural and scientific promotion) by Delphi methods. FRA also conducted a web-based survey to gain insight into public demand for policies. The questionnaire asked the respondents to choose what they thought were the important usages of the waters around Japan (the total number of results analyzed was 2000, with a maximum of two choices). Of all respondents, 83.3% chose “food production by fisheries,” followed by “generation of energy from tidal power or offshore wind power” (54.4%), “transportation” (21.0%), “recreational use” (8.2%), and “creation of space by land reclamation” (1.9%). The respondents who chose “food production by fisheries” were the largest group in every region, and the higher the age bracket, the greater number of such respondents (FRA, 2009).

Shiretoko World Natural Heritage Area

The Shiretoko Peninsula, in northeastern Hokkaido, is the southernmost seasonal limit of sea ice in the Northern Hemisphere. This region is characterized by closely linked terrestrial and marine ecosystems, and by a number of marine and terrestrial species, including several endangered ones. In 1964, the Shiretoko Peninsula and its surrounding marine areas were designated a National Park, and added to the UNESCO World Heritage List in July 2005. In order to propose necessary policy measures and to evaluate the efficiency of EBM measures, an institutional analysis was conducted to identify the gap between the existing fisheries management framework and EBM. A cost-benefit analysis showed that the costs for EBM measures correspond to 0.8% of the sum of the production by two major industries in the area, *i.e.*, fisheries and tourism (Makino *et al*., 2009).

Sato-Umi in Okinawa

Sato-Umi (meaning “village seas” in Japanese) is defined as the coastal sea that has high productivity and biodiversity with human actions (Yanagi, 2006). To achieve it, a big, long, smooth material circulation is needed by implementing environmental conservation from mountain to sea, and marine living resource conservation from the context of the food chain and ecosystems. The Sato-Umi concept is composed of the combination of biological/ecological systems in the coastal sea, and the historical/cultural/ socio-economic systems in the coastal land. Tools in anthropology and sociology are applied to understand historical processes, culture, and economics. Several non-market valuation analyses were conducted for coral reef Sato-Umi areas in Okinawa. In 2008, the Ministry of Environment started the Sato-Umi Creation Support Project, and seven cases have been designated as models for the Sato-Umi approach (Hirota, 2010).

4.3 People's Republic of China

Institutional analysis for EBFM

The term ecosystem-based fisheries management is neither a new concept nor a new idea for most Chinese scholars engaged in fisheries management studies. For example, *Chinese Fisheries Economics*, a professional journal for Chinese scholars specialized in the field of fisheries economics and management, published a paper entitled "The Theoretical Research about the Ecosystem-based Fishery Management" in 2006. It gave a detailed explanation about what EBFM is, why EBFM is proposed, what principles should be followed when EBFM is implemented, and how the existing management system should be modified if China aims to transform to EBFM. Chen (2010) summarized the major institutional frameworks and activities for EBFM in China, following seven questions about the introduction of EBFM:

1. political willingness (strong at city level, moderate at provincial level, weak at the central level),
2. financial budget (more at the central level, moderate at provincial level, less at city level),
3. scientific support (not enough),
4. institutional background for EBFM action (not ready),
5. enforcement (generally weak),
6. right spatial-scale for EBFM,
7. successful case studies (do not yet exist).

Also, in order to identify the gap between existing fisheries management frameworks and EBFM, and to propose the necessary road map for better management with a catch quota system, institutional analyses based on property right regimes and policy circle theory have been conducted (Mu and Liang, 2010).

Non-market valuation for the Yellow Sea, South China Sea, East China Sea, and Bohai Sea

Non-market valuation tools are intensively utilized in China (*e.g.*, Liu *et al*., 2008). In addition, a software program named MEGA-MES (Marine EcoloGical Assessment Group-Marine Ecosystem Service Valuation Software), which is based on non-market valuation tools and the results from bio-physical analyses, was developed for evaluating food production, material production, oxygen production, climate regulation, waste treatment, recreational service, scientific service, and species diversity maintenance. (Chen *et al*., 2006). MEGA-MES has been applied to the Yellow Sea, South China Sea, East China Sea, Bohai Sea.

Aquaculture site selection

GIS analysis was conducted in order to determine the recommended domains (places where certain target production systems and technologies may be feasible for introduction and adoption by farmers) for promoting freshwater aquaculture development aimed at helping to improve household food security and livelihoods of smallhold farmers (Yang, 2007). In this analysis, wide-ranging approaches and tools, from both social sciences and natural sciences, were integrated using GIS. For example, results from bio-physical analyses on the environmental factors that determine the potential for a certain technology, and the results from socio-economic analysis and policy factors that affect sustained adoption of the technology, were integrated using GIS. Also, the cultural background and infrastructure were considered as the enabling institutions for aquaculture.

4.4 Republic of Korea

Risk analysis for the large purse seine fishery

Integrated Fisheries Risk Assessment, Forecasting and Management for Ecosystems (IFRAME) is a comprehensive risk analysis model for EBFM (Zhang *et al*., 2009). It is composed of four attributes: sustainability, biodiversity, habitat, and socio-economics, including indicators for each attribute. As a socio-economic attribute, four indicators are developed, such as economic production, revenue/income, market, and employment. They evaluate the change of socio-economic effects together with other attributes. In the future, more consideration on developing effective indicators is needed. If they are developed by collecting necessary data, they will provide useful information for the evaluation of fisheries management measures. As a case study, IFRAME was applied to the Korean large purse seine fishery to assess the effects of the climate change, such as economic revenue, seafood market, and employment as well as the ecological analysis on biomass, trophic level, and bycatch. The results suggested that the level of fishing mortality should be reduced by about 25% to adapt stably and effectively to future changes in climate (Kim and Zhang, 2011).

Economic effects of the fry release program

The fry release program has operated in Korea since 1976. It was implemented in order to complement and enhance the recruitment of insufficient fishery resources by releasing fry to increase catch limits, to increase the income of small-scale fishermen in coastal fisheries, and to promote the vitalization of fishing villages. Records of the fry release program show that the total number of released fish between 2004 and 2007 was about 400 million and the types of released fish included giant prawn, flatfish (Oliver flounder), abalone, and rockfish. The program continues to expand and is expected to grow with the necessity of fish stock recovery. In order to evaluate the economic effects of the fry release program, various economic tools such as net present value, cost-benefit ratio, and internal rate of return were applied for Oliver flounder. Also, the increases in public welfare (cultural service) were estimated by non-market valuation tools such as travel cost methods, random utility models, and contingent valuation methods.

Stock rebuilding plan for sandfish

In Korea, a fish stock rebuilding plan (FSRP), combined with conventional fish stock enhancement programs, was established in 2005 (Lee, 2010). Sandfish (*Arctoscopus japonicus*) was selected as a target species for the rebuilding plan in 2006. Sandfish was chosen because of the large reduction in catch that resulted from overfishing of adult sandfish, reckless fishing of fingerlings and destruction of spawning grounds. Sandfish is caught in many fisheries including the gill-net fishery and trawl fishery, but is mainly done by the Danish seine fishery and coastal gill-net fishery. A rebuilding period was set as 10 years, with target catch determined for each year. Target catches were initially set at 2,600 tons for 2006, 3,700 tons for 2007 and 5,000 tons for 2015. Using a bioeconomic modeling technique based on stock investigation and evaluation results, target stock accomplishments during the rebuilding period and economic effects were analyzed. Four policy alternatives were analyzed to estimate the change in sandfish stock for the next 25 years, and change in profit of target fisheries (Kim, 2009).

4.5 Russia

Ecosystem service values in the Kamchatka region

In order to evaluate the total value of marine natural capital (water biological resources, oil and gas resources, and hydro-energetic resources) and ecosystem services, non-market valuation tools were applied (Shirkov, *et al*., 2006). The results suggested that the value of non-market ecosystem services was higher than the benefit from oil and gas exploitation.

Assessment of economic losses from marine pollution and water engineering at Sakhalin Island

A lot of funds were invested by Russia and foreign countries to the economy of the Sakhalin region in 2000–2004. In this period, per capita income increased 1,5 percent per month. However, because of rapid development in oil exploitation, a lot of damage occurred in the fisheries sector. Income from oil exploration is not the reason for fishery ignorance in this region. Synyakov *et al*. (2006) estimated the total economic damage to fish incurred from marine pollution and water engineering in oil processing on northeastern coast of Sakhalin Island at US$15 million in 2000–2009. This means economic losses were larger than the economic investment in the region.

Assessment of ecosystem service values and economic losses in Primorsky Kray

Ecosystem service values in Peter the Great Bay (south coast of Primorsky Kray) were estimated in 2009.The cost of biological resources (fish, marine invertebrates, seaweeds) was only 10% of the total value of ecosystem services of the Bay (Lukyanova *et al*., 2010a). On the other hand, economic losses in the fisheries sector incurred from water engineering (construction of bridges, *etc*.) on the coast and the rivers on the territory of Primorsky Kray amounted to about US$300,000 in 2009–2010 (Lukyanova *et al*., 2010b).

4.6 United States of America

Environmental Assessment

The Environmental Assessment system of the U.S. National Environmental Policy Act (NEPA) requires federal agencies to document the problem to be addressed by the proposed actions, to identify the alternatives to be considered, to describe the affected environment, and to analyze the alternatives. Many social and economic factors such as public participation, technical and allocative efficiencies, and regional impacts are included in this assessment process. For example, when the government is going to introduce a fisheries management measure that needs to be addressed by the Environmental Assessment, participation by fishers, processors, and crews will be analyzed using tools in sociology, geography, *etc*. Also, using the tools in economics and area studies, tax revenues or regional impacts for local communities are analyzed. For consumers, product quality and availability are considered based on the tools in seafood business.

Fisheries management in Alaska

The North Pacific Fishery Management Council (NPFMC) has implemented six Fisheries Management Plans (FMPs): the Bering Sea and Aleutian Islands (BSAI) groundfish FMP, Gulf of Alaska (GOA) groundfish FMP, the Arctic Management Area FMP, the BSAI crab FMP, the scallop FMP, and the salmon FMP. These FMPs govern the setting of annual catch limits, restrict fishing practices relating to gear, bycatch and discard requirements, administer the allocation of fishery privileges among fishers, and constrain spatial and temporal access to fishery resources. Annual stock assessment and fishery evaluation (SAFE) is the base of such management measures. It includes not only bio-physical analyses but also the social and economic impacts analysis. For example, the social and economic HYPERLINK "E:\\from" shares market-based consolidation, fleet composition, distribution and abundance trends in the human population. Also, when prohibition on the retention of forage fish is specified by FMPs, economic analysis such as opportunity costs, monitoring and enforcement costs, and impacts on small entities are considered (Criddle, 2010).

Puget Sound Partnership

The Puget Sound Partnership (PSP) is a community effort of citizens, governments, tribes, scientists and businesses working together to restore and protect Puget Sound. PSP is a coordinating agency, not a regulatory agency. It coordinates federal, state, local tribal and private resources, and makes sure that all are working cooperatively. Its goal is to make Puget Sound healthy again, and to create a roadmap for how to get it done. PSP is designated as the lead entity for integrating estuary and watershed protection programs for Puget Sound under the National Estuary Program (U.S. Clean Water Act sec. 320). The Science Panel, which is the scientific advisory body of PSP, has adopted Integrated Ecosystem Assessment (IEA) as a central organizing tool. It offers a means to model and test linkages among ecosystem threats, management activities, and environmental and social/economic goals (Levin *et al*., 2009). Elements of the IEA include:

1. refining ecosystem goals and objectives,
2. conducting risk analyses,
3. developing and evaluating policy strategies, and
4. monitoring ecosystem status and effectiveness of actions (Puget Sound Partnership, 2010).

As base information to set a definition of a healthy ecosystem, to identify threats, and to prioritize various indicators, a cognitive study was conducted on local stakeholders to grasp their recognition of the values and states of Puget Sound. Results are to be applied to the Integrated Ecosystem Assessment models (Fluharty, 2010).

5 Discussion

Table 4.1 shows that wide-ranging social science approaches and tools have been, or are being, introduced in a variety of locations and scales in PICES member countries. In reality, most of the major social science approaches and tools listed in Table 3.1 have been already introduced or are being introduced in the member countries. This fact strongly implies that each member country has a rich source of experienced researchers for the analysis of human dimensions. In other words, once an expert group of social scientists from the member countries is formed under the PICES framework, it can conduct high-level and comprehensive studies on human dimensions for EBFM in the North Pacific. Such an expert group would contribute significantly to the value of the PICES integrative science program FUTURE (**F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems) to improve the applications to, and understanding by, stakeholders.

It should be noted that, as the terms of reference for SG-HD clearly addresses, different marine sectors view ecosystems in terms of their own economic, cultural and societal needs. Therefore, the social significance of predicted impacts from climate or ecosystem changes, and the types of information, advice and guidance to be requested of FUTURE might differ from country to country and sector to sector. Based on sound social science approaches and tools introduced in this report, an important next step is to survey/assess the needs of potential stakeholders for FUTURE products, and scientifically clarify differences in societal objectives and needs among stakeholders in different sectors and member countries.

Spatial-scale issues are another challenge for social science analysis. Many application cases listed in Table 4.1 are basically at the local scale. With a close relationship to the bio-physical products from FUTURE, it might be worth trying to discuss the possibility of applying social science tools at larger marine ecosystem scales.

Another, but not less, important challenge for the social sciences is to conduct research (or Topic Sessions) which fit the FUTURE perspectives. For example, the social system’s response to climate change and uncertainties (vulnerability analysis, indicators of the human dimensions, *etc*.) could be the candidates for such analyses.

6 Recommendations

Members of SG-HD had intensive discussions on how the findings and work of this report could best be integrated and built upon within PICES in the years ahead, particularly within the context of the PICES FUTURE program. One of the most important differences between FUTURE and its predecessor, the PICES/GLOBEC Climate Change and Carrying Capacity (CCCC) program is that FUTURE is placing greater emphasis on societal concerns that arise from changes in North Pacific marine ecosystems (PICES, 2008). Taking this into account, the findings and work of SG-HD can make significant contributions both to FUTURE and to the activities of the PICES standing committees, in particular, the Fishery Science Committee and Marine Environmental Quality Committee, as described below.

The FUTURE Science Plan (PICES, 2008) sets the Third Research Theme as “How do human activities affect coastal ecosystems and how are societies affected by changes in these ecosystems?” More precisely, a full exploration of Key Question 3.4 “What will be the consequences of projected coastal ecosystem changes and what is the predictability and uncertainty of forecasted changes?” should include an assessment of the potential social consequences caused by the ecosystem changes such as decreases in fisheries incomes, distribution of wealth among sectors or areas, and influences on demographic profiles of coastal communities. The social sciences have a wide range of analytical tools (quantitative and qualitative) which can be applicable for this purpose, as described in section 3.1 of this report.

Also, the FUTURE Key Question 3.5 “How can we effectively use our understanding of coastal ecosystem processes and mechanisms to identify the nature and causes of ecosystem changes and to develop strategies for sustainable use?” requires objective and technical information for developing coping, adaptation and mitigation strategies (note that PICES is not a policy organization). In this regard, the social sciences can support the setting of management objectives by evaluating the likely social and economic consequences of alternative management actions, assessing priorities among issues, and identifying socio-economic indices related to the state of fisheries and ecosystems. One of the major issues in developing coping strategies is the multiplicity of scales (spatial, temporal, and organizational) at which the social and ecological systems interact. The social sciences can contribute analytical tools for better coordination between existing institutional scales (stakeholders) and natural scientific knowledge.

FUTURE seeks to increase awareness of the ecological and societal importance of the North Pacific within PICES member countries (PICES, 2009). The FUTURE Implementation Plan sets Objective 2 as the production of status reports, outlooks, forecasts, and engagement potential users (community, industry, government, international organization) on issues relating to North Pacific ecosystems and climate. The social sciences are uniquely positioned to contribute to efforts on engagement. It should be noted though, that because different regions or sectors view ecosystems in terms of their own economic, cultural and societal needs, the communication requirements are different, and therefore the information provided by PICES should be tailored differently.

There are several other international research activities with common interests and objectives. For example, one of the Key Questions in the Science Plan for the ICES Strategic Initiative on Climate Change Effects on Marine Ecosystems is “How will societies that depend on ecosystems services respond to climate-driven changes in ecosystem services, and which responses are consistent with an ecosystem approach to management?”. The Integrated Marine Biogeochemistry and Ecosystem Research (IMBER, a core project of the International Geosphere–Biosphere Programme, IGBP) Human Dimensions Working Group is focusing its activities on the multiple feedbacks between human and ocean systems. The objective of the Land-Ocean Interactions in the Coastal Zone (LOICZ; also an IGBP core project) includes developing and testing integrated multidisciplinary (natural + economic + social) methods to analyze the environmental and social interactions and feedbacks governing coastal system status and changes. PICES needs to interact with these groups to facilitate academic communication and discussions on marine issues.

Taking all of the above into account, SG-HD recommends that PICES establish a new expert group (potentially a "Section") related to the social sciences. Recognizing the longer-term requirement of the activities of this group (*i.e.*, longer than the usual 3-year duration of PICES Working Groups), SG-HD recommends this expert group be established for the entire duration of the PICES FUTURE program (contingent upon adequate performance, for example, the practice for PICES Sections to be reviewed every 3 years) and that it be placed under, and report to, Science Board. As Table 3.1 shows, the social sciences are composed of several wide-ranging disciplines. Therefore, it is desirable that at least three members with balanced specialties from the social sciences and natural sciences should represent each member country. The following is a draft proposal for the expert group.

Objective

To better understand and communicate the societal implications of the conditions and future trends of North Pacific marine ecosystems (a vision of the PICES FUTURE program), to provide a forum for the integration of FUTURE-related studies using social science approaches and tools, and to facilitate the close discussions and communications among researchers from both the natural and social sciences.

Draft Terms of Reference

The Section on *Human Dimensions of Marine Systems* (S-HD) is the scientific body responsible for the promotion, coordination, integration and synthesis of research activities related to the contribution of the social sciences to FUTURE, to PICES Scientific Committees, and to PICES as an organization.

1. S-HD will work towards scientific clarification of differences in societal objectives and needs among stakeholders in different sectors and countries. Based on that result, S-HD will develop an inventory of potential recipients, and their communication requirements for FUTURE and other PICES products, such as the state of the ocean reports (FUTURE Objective 2).
2. Based in part on the results of TOR 1, and with close coordination and communication with SOFE-AP and other expert groups within PICES, S-HD will scientifically explore the consequences to and responses of human social systems to climate-induced changes in marine ecosystems (FUTURE key question 3.4). Social science tools summarized in Table 3.1 of this report will be applied to such an analysis.
3. S-HD will contribute a Human Dimension Chapter to the next Ecosystem Status Report (FUTURE Objective 2).
4. S-HD will facilitate academic cooperation with other international research activities such as ICES, IMBER, LOICZ, *etc.*, and organize a symposium on the study of the human dimensions of marine ecosystems.

Membership

We recommend a membership that will ensure core connection with PICES Committees, key expertise from the various social and natural science disciplines, and national representation. We advocate a nomination process that closely connects this group to PICES Scientific Committees through, for example, ensuring that at least one member or designate be drawn from each Committee. The membership for the new Section should include: (1) at least some individuals who participated in SG-HD and (2) experts from the various natural and social science (economy, geography, sociology, anthropology, *etc*.) disciplines.

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8 Appendices

8.1 Study Group on *Human Dimensions* Membership*

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8.2 Seven Steps for the Work of the Study Group on *Human Dimensions*

<Step 1> April 15, 2010: A draft table of categories and tools in social sciences was made.

<Step 2> June 23, 2010: Each Study Group member reviewed applications/experiences of social science tools for EBFM in his/her country.

<Step 3> June 24–25, 2010: An inter-sessional meeting was held in Yokohama, Japan, to review results of each member country's applications/experiences. Based on the results, a table of categories in social science disciplines and their tools was finalized.

<Step 4> End of August 2010: The review scope was expanded to other social science disciplines. Based on the results from the Yokohama meeting, the Chairman proposed that each Study Group member conduct a review on his/her specialty, and make a brief report.

<Step 5> Beginning of October 2010: A draft of the final report (review of results, inventory of practices, and recommendations) was circulated by the Chairman to the Study Group.

<Step 6> October 22, 2010: The final SG-HD meeting was held at PICES-2010 in Portland, U.S.A., to finalize the contents of the report.

<Step 7> April 29, 2011: A draft of the SG-HD final report was presented at the inter-sessional Science Board meeting in Honolulu. The draft was then circulated to other specialists and expert groups in PICES, and submitted to the PICES Secretariat before PICES-2011 in Khabarovsk, Russia.

8.3 Session Summary (2008) and Meeting Report (2010) from Past PICES Annual Meetings

PICES Seventeenth Annual Meeting
October 24–November 2, 2008
Dalian, China

SUMMARY OF SCIENTIFIC SESSIONS AND WORKSHOPS

MEQ Topic Session (S12)
Connecting the human and natural dimensions of marine ecosystems and marine management in the PICES context

Co-Convenors: David L. Fluharty (USA), Mitsutaka Makino (Japan), R. Ian Perry (Canada) and Chang-Ik Zhang (Korea)

Background

A complete definition of marine ecosystems includes the human components. Consideration of ecosystem-based management, at least within the natural sciences, usually leaves out the human dimensions, or includes it only as fishing effort. For ecosystem-based management to succeed, however, humans need to be included. This session builds on the Science Board Symposium of 2003 titled "*Human dimensions of ecosystem variability*". Human relationships and how humans interact with the ocean have been changing in nature and strength over time. Natural variability in marine systems can be large, but so are socio-economic pressures and considerations relating to marine environments. Determining appropriate socio-economic indicators to complement indicators of natural climate variability, *e.g.* for ecosystem-based management, is an ongoing challenge. This session will address these interactions between natural and socio-economic issues in the context of ecosystem-based management. Specifically, it will consider: (1) What are the criteria to determine relevant socio-economic indicators of human well-being related to marine issues for PICES member countries? (2) What are appropriate indicators to monitor changes in management objectives and human well-being relevant to changing ecosystem structure and production? (3) How might decisions that are made to enhance human well-being likely to impact (positively or negatively) the nature and functions of marine ecosystems? This session theme will continue to explore the many ways that humans interact with marine ecosystems and the scientific efforts to quantify and predict human impacts on the dynamics of such systems.

Summary of presentations

Ten oral (including 1 invited) and 13 posters were presented in this session. After the introduction of this session from Mr. Fluharty (U.S.A) on behalf of the co-convenors, Dr. Makino reviewed the social and ecological conditions of fisheries with respect to management strategies. Then, Dr. Hamilton (Invited, University of New Hampshire, U.S.A.) presented the relationships between ecosystems, fisheries and social changes in western Alaska. Dr. Zhang reviewed the socio-economic indicators used in ecosystem-based assessments for the Eastern Bering Sea trawl fishery. After the introduction of environmental contaminants in Pacific food webs and their implications for coastal First Nations by Dr. Ross, Dr. Fluharty talked about the use of social science information in marine management processes in the U.S.A. Four more studies were then presented from Korea (by Dr. Park), China (Dr. Chen and Dr. Zhang), and Russia (Dr. Lukyanova). Dr. Pooley reported the results of a related symposium, convened by GLOBEC and co-sponsored by PICES, which was held at FAO headquarters in July 2008, and which was convened by Dr. Perry. The session concluded that we should continue to explore the many ways that humans interact with marine ecosystems and the scientific efforts to quantify and predict human impacts on the dynamics of such systems.

List of papers

Oral presentations

Mitsutaku Makino and Hiroshi Horikawa
Social-ecological conditions of fisheries and management by ITQs: A global review

Lawrence C. Hamilton (Invited)
Ecosystem, fishery and social changes in western Alaska

Chang Seung and Chang-Ik Zhang
Socio-economic indicators used in ecosystem-based assessment for the eastern Bering Sea trawl fishery

Peter S. Ross, T. Child and N. Turner
Caught in the crossfire: Environmental contaminants in Pacific food webs and implications for coastal First Nations

David L. Fluharty
Developing and using social science information in marine management processes in the United States

Hee Won Park, Chang-Ik Zhang and Jae Bong Lee
A comparative study on the structure and function of Korean marine ranching ecosystems

Shang Chen, Jian Liu, Tao Xia and Qixiang Wang
Change of ecosystem services of the Yellow River Delta Wetland, China

Olga N. Lukyanova and Ludmila V. Nigmatulina
The value of ecosystem services of Peter the Great Bay (Japan/East Sea)

Samuel G. Pooley, Ian Perry and Mitsutaku Makino
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Zhen Wang, Xindong Ma, Zhongsheng Lin, Guangshui Na, Qiang Wang and Ziwei Yao
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Guangshui Na, Qiang Wang, Zhen Wang, Hongxia Li, Shilan Zhao, Tong Chen, Zhongsheng Lin and Ziwei Yao
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Li Zheng, Xuezheng Lin, Zhisong Cui, Frank S.C. Lee and Xiaoru Wang
Phylogenetic analysis of indigenous marine bacteria with the ability to degrade oil pollutants in Bohai Bay

Liping Jiao, Liqi Chen, Yuanhui Zhang, Gene J. Zheng, Tu Binh Minh and Paul K.S. Lam
Polycyclic aromatic hydrocarbons in remote lake and coastal sediments from Svalbard, Norway: Levels, sources and fluxes

Qixiang Wang, Shang Chen and Xuexi Tang
Preliminary assessment of ecosystem services of the Yellow Sea

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Zhang Hongliang, Leng Yu, Xu Zijun and Li Jiye
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Zhou Yan-Rong Zhang Wei Tang Wei Zhao Bei andYang Dong-Fang
Analysis of nutrients and organic pollution in Shuangdao Bay

Ji-Ye Li, Xiu-Qin Sun, Feng-Rong Zheng and Lin-Hua Hao
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Wang Xinping, Sun Peiyan, Zhou Qing, Li Mei, Cao Lixin and Zhao Yuhui
Compounds concentration analysis of oil and its application in oil spill identification

PICES Nineteenth Annual Meeting
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Portland, U.S.A.

2010 REPORT OF THE STUDY GROUP ON *HUMAN DIMENSIONS*

Background and Terms of Reference

The Implementation Plan for the new PICES integrative science program on **F**orecasting and **U**nderstanding **T**rends, **U**ncertainty and **R**esponses of North Pacific Marine **E**cosystems" (FUTURE) calls for PICES scientists to make the societal implications of their science more explicit and accessible through long-term engagement and communication activities among scientists, decision makers, stakeholders, and across sectors. Because different marine sectors view ecosystems in terms of their own economic, cultural and societal needs, the objective of ecosystem conservation is "a societal choice" (Principle 1 of the Ecosystem Approach of the Convention on Biological Diversity). Therefore, the social significance of predicted impacts from climate or ecosystem changes, and the types of information, advice and guidance to be requested of FUTURE might differ from country to country and sector to sector.

The objective of the Study Group on *Human Dimensions* (SG-HD), established at PICES-2009 in Jeju, Korea, under the direction of Science Board (Decision 09/S7/(iii)), is not to design management systems or plans, and outreach steps, but to review the role of social sciences practices applied in decision-making in marine sectors around the world. In order to fully utilize the limited time frame of the Study Group (one year), the main focus will be on ecosystem-based fisheries management (EBFM).

The Study Group intends to:
- Review how social science has been used/applied globally and regionally in EBFM, and the theoretical basis for these practices;
- Review the social scientific tools and information available for EBFM in PICES member countries;
- Develop an inventory of practices for use of social economic information appropriate to the circumstances in each PICES member country (the term "best practice" is not used because it is expected that what is considered "best" will vary and be determined according to the circumstances in each of PICES member country);
- Prepare a final report on activities and findings of the Group and make recommendations on the desirability of establishing an expert group related to socio-economic sciences within PICES, and on the role of such a group. For example, based on sound social and economic science, the potential expert group should first survey/assess the needs of potential stakeholders for FUTURE products, and scientifically clarify differences in societal objectives among stakeholders in different sectors and member countries.

The approved membership of the Study Group can be found in *SG-HD Endnote 1*.

Study Group process

SG-HD completed, or will complete, the following tasks, as described in the seven steps shown below.

<Step 1> April 15, 2010: A draft table of categories and tools in social sciences was made.
<Step 2> June 23, 2010: Each Study Group member reviewed applications/experiences of social science tools for EBFM in his/her country.

<Step 3> June 24–25, 2010: An inter-sessional meeting was held in Yokohama, Japan, to review results of each member country's applications/experiences. Based on the results, a table of categories in social science disciplines and their tools was finalized.

<Step 4> End of August 2010: The review scope was expanded to other social science disciplines. Based on the results from the Yokohama meeting, the Chairman proposed that each Study Group member conduct a review on his/her specialty, and make a brief report.

<Step 5> Beginning of October 2010: A draft of the final report (review of results, inventory of practices, and recommendations) was circulated by the Chairman to the Study Group.

<Step 6> October 22, 2010: The final SG-HD meeting was held at PICES-2010 in Portland, U.S.A., to finalize the contents of the report.

<Step 7> April 2011: A draft of the SG-HD final report will be presented at the inter-sessional Science Board meeting in Honolulu. The draft will then be circulated to other specialists and expert groups in PICES, and submitted to the PICES Secretariat before PICES-2011 in Khabarovsk, Russia.

Results of activities in 2010

SG-HD first discussed the "conventional" social science disciplines related to EBFM (Step 1). They are:
1. Anthropology/Ethnology,
2. Economics (bioeconomics, decision theory, non-market valuation, commons, accounting, *etc.*),
3. Geography/Area studies,
4. Law/Political science,
5. Sociology,
6. Psychology,
7. Inter-disciplinary methodologies (impact analysis, GIS, management science, *etc.*).

The Study Group also made a table of social scientific tools in each discipline which can be applied to EBFM studies.

Each member of the Study Group reviewed applications of the social scientific tools identified in Step 1, and reported the results at the Group's inter-sessional meeting held in Yokohama in June 2010 (Steps 2 and 3). The travel costs of two participants were covered by PICES, and other expenses were covered by each PICES member country and the Fisheries Research Agency of Japan.

At the Yokohama meeting, Canada discussed marine use, demographic analysis, *etc.* in the Pacific North Coast Integrated Management Area (PNCIMA), a guidance document on the use of socio-economic objectives for the creation of MPAs. China presented the new development of Marine Ecosystem Service Evaluation Software, and its application to the Yellow Sea, South China Sea, East China Sea, and Bohai Sea. Social analysis in Sato-Umi (village sea) initiatives and institutional analysis of the Shiretoko World Natural Heritage site were summarized by Japan. Korea talked about the application of the IFRAME (Integrated Fisheries Risk Assessment, forecasting and Management for Ecosystems) for large purse seiners and bioeconomics for Resource Recovery Plan, *etc*. Russia showed a case study of non-market valuation of ecosystem values at Kamchatka, or economic losses from water pollution in Primorsky Kray. The United States reviewed NOAA's Annual Stock Assessment, the NEPA Environmental Assessment, and Integrated Ecosystem Assessment in the Puget Sound.

Based on the results of Step 3 (from the Yokohama inter-sessional meeting), the Study Group members conducted an additional review of social scientific tools for EBFM (Step 4), and discussed the contents of the final report via e-mail (Step 5).

On October 22, 2010, the Study Group held its final meeting at PICES-2010 (Step 6). At this meeting, the detailed structure of the Study Group final report was decided. The Study Group also discussed the role of social sciences in EBFM as follows: 1) to make scientific inputs on how to define/select the goals, objectives, indicators, targets, *etc*., 2) to make scientific inputs on how to judge/asses the performances of specific EBM measures, 3) to improve the value of bio-physical information (for better understanding by the public, management and fishers), 4) to propose spatial/temporal/organizational scales for EBFM, coordinating with existing institutional scales (stake holders) and natural scientific knowledge.

Finally, the Study Group drafted the recommendations. In order to better understand and communicate the societal implications of the conditions and future trends of North Pacific marine ecosystems (FUTURE vision), it is desirable to establish a new expert group related to social sciences. The terms of reference for the new group would include a survey/assessment of the needs of potential stakeholders for FUTURE products, and scientific clarification of differences in societal objectives and needs among stakeholders in different sectors and countries. For example, the new expert group will be engaged in vulnerability analysis, indicators on human dimensions for EBFM, bioeconomics, *etc*. The Study Group also agreed that the new expert group can make a contribution to the next North Pacific Ecosystem Status Report, and organize a symposium on Human Dimensions for EBFM.

The draft of the final report with recommendations will be finished by the end of January 2011 (Step 7). However, because the issue of human dimensions is important and relevant to the FUTURE program (especially to SOFE-AP) and several other groups within PICES, we suggested it is important to circulate this draft to other groups for their comments and suggestions. The revised version, which includes comments, will be submitted to the inter-sessional Science Board meeting (expected to be held in April 2011). Based on the comments received at the inter-sessional meeting, SG-HD will finalize the report and recommendations by PICES-2011.

SG-HD Endnote 1

SG-HD membership

Shang Chen (China)
Keith R. Criddle (U.S.A.)
David L. Fluharty (U.S.A.)
Masahito Hirota (Japan)
Dohoon Kim (Korea)
Olga N. Lukyanova (Russia)
Mitsutaku Makino (Japan, Chairman)
Jongoh Nam (Korea)
Rowena Orok (Canada)
Ian Perry (Canada)
Ningsheng Yang (China)

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